International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 7 Issue 2, March-April 2023 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Automatic Fire Extinguisher Robot with Obstacle Avoidance

Dr. Venkat. P. Patil, Ammar Ansari, Haider Dahodwala, Shubham Phatkare

Smt. Indira Gandhi College of Engineering, Navi Mumbai, Maharashtra, India

ABSTRACT

A fire fighter's life is in constant danger as they attempt to detect and extinguish fires. Every year, a distressing number of firemen worldwide are murdered in on-the-job fires. Robotics is the result of years of research and development in the field of artificial intelligence. Robots have numerous applications, including industrial and medicine. As a result, robotics can be used to assist firemen in their work and reduce the risk they encounter. The Fire Fighter robot was specifically designed for usage in hazardous areas. After finding the source of the fire, it can be programmed to operate and control itself to extinguish it. To help it avoid obstructions, it features a microcontroller, smoke detectors, and an ultrasonic sensor. The robot fire fighter's sensors are used to construct the fire detection system. The robot's microcontroller allows it to work independently. This concept piques people's interest and inspires new robotics innovations as we get closer to a realistic and attainable solution that could save lives and prevent property damage.

KEYWORDS: *Firefighting robot, Microcontroller, Fire Sensors, Ultrasonic Sensors*

How to cite this paper: Dr. Venkat. P. Patil | Ammar Ansari | Haider Dahodwala | Shubham Phatkare "Automatic Fire Extinguisher Robot with Obstacle Avoidance" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-7 | Issue-2, April 2023, pp.698-707, URL: www.ijtsrd.com/papers/ijtsrd55137.pdf

IJTSRD55137

INTRODUCTION

Both putting out fires and rescuing people from them are hazardous occupations. Firefighters are frequently placed in dangerous situations while putting out flames. Firefighters battle high-rise fires, hauling heavy hoses and scaling lofty ladders to rescue victims. Firefighters must deal with a difficult environment that includes high temperatures, dust, and low humidity, in addition to working long, unpredictable shifts. They also put their lives at peril in situations like as explosions and building collapses. According to the IAFF, an average of 1.9 fire fighters were killed for every 100,000 structure fires in the United States in 2000. Yet, the rate was increasing to three fires per 100,000 people. People die on the job for a variety of reasons, including smoke inhalation, burns, crushing injuries, and other forms of trauma. Firefighter fatalities occur on a yearly basis, according to statistics. As a result, fire departments require firefighting equipment to assist their people in potentially deadly situations.

Robotics engineering is one of the most dynamic fields in the modern world. Robots are designed to accomplish activities that are either dangerous or too difficult for humans, or to act in regions where humans cannot. In today's culture, the presence of robots is unparalleled.

The development of such a technology considerably increases the number of lives saved and the quantity of property saved from fire destruction. As engineers, we were charged with creating a prototype system capable of detecting and extinguishing flames without the need for human interaction. As a supplementary purpose, efforts are made to reduce air pollution. In this project, we created a radio-frequency-controlled robot. This firefighting activity might be safer if performed by a robot that can be remotely controlled or that can act intelligently on its own. A robot is a mechanised machine that is employed for dangerous duties such as firefighting. Fixed base robots, mobile robots, underwater robots, humanoid robots, space robots, medical robots, and so on are only a few of the many types of robots.

Fixed-base robots are limited in their capabilities due to the way they are manufactured. The robot's workspace is increased by putting it on wheels. They are known as mobile robots. The major purpose of this essay is to use an Android application to build a

firefighting robot. Mobile robots are used in mining, the military, forestry, security, and other industries. In these cases, the employment of robot technology can save more lives. Robotics, in this way, not only saves humans time, but also makes them more efficient and secure. Fast technological improvement has resulted in improved firefighting equipment.

Employing a robot that can be directed remotely or that can function intelligently on its own would make firefighting safer. Robots, mechanical equipment used in hazardous occupations such as firefighting, are becoming more popular. Fixed base robots, mobile robots, underwater robots, humanoid robots, space robots, medical robots, and so on are only a few of the many types of robots. Fixed-base robots are limited in their capabilities due to the way they are manufactured. The robot's workspace is increased by putting it on wheels. They are known as mobile robots. Mobile robots are used in mining, the military, forestry, security, and other industries. Fires in tunnels, factories, hospitals, laboratories, and even homes are no match for mobile robots. The employment of firefighting robots reduces the need for human firefighters to risk their lives. Also, the robot will make the lives of firemen easier. It is impossible to put out fires and save a huge number of people at the same time during a catastrophic disaster. In these cases, the employment of robot technology can save more lives. Robotics, in this way, not only saves humans time, but also makes them more efficient and secure. Fast technological improvement has resulted in improved firefighting equipment. New tools and equipment may boost production. In addition, the acceptable risk threshold is lowered. This will help reduce the damage caused by a fire.

LITERATURE SURVEY

Fighting fires involves extinguishing flames as rapidly as possible in structures, vehicles, and forests. To save lives, property, and the environment, a firefighter extinguishes fires.

Most firefighters undergo extensive technical training. Both structural and wildfire suppression fell under this category. Specialized firefighting training is available for aircraft, ships, the air, the sea, confined spaces, and maritime emergencies, among others.

However, various types of fires, such as those involving grease, paper, electricity, etc., require different types of extinguishers. The various categories reflect the types of fires for which each extinguisher is best suited.

In the third century B.C., Ctesibius, a Greek engineer from Alexandria, devised the siphona, a double-force pump. The rising water exerted pressure on the chamber's air, causing water to flow consistently from a nozzle.

In the 16th century, larger injectors mounted on wheels were used as firefighting equipment. The bucket brigade, in which two lines of people are formed between the water source and the fire, was another historic and enduring firefighting technique. Empty pails would be passed back to be refilled by women and children, while men in a single line would pass full pails of water towards the fire.

In the seventeenth century, some of the earliest fire engines were constructed in Amsterdam. In 1721, English inventor Richard Nisham created a popular fire engine consisting of a rectangular box on wheels laden with water by a bucket brigade to provide a reservoir, and then manually pumped with sufficient force to extinguish flames at a distance.

Firefighting is one of the most hazardous and difficult occupations in the world. Modern firefighting is an occupation fraught with danger. Several authors are developing novel techniques for fighting fires. We have developed a mechanised firefighting strategy. The mechanical firefighter has been constructed and designed. This automaton operates completely independently. The application of concepts such as environmental perception and awareness and proportional motor control. Sensor data and hardware data are processed by the robot. Temperature and infrared sensors are used for environmental monitoring. The robot can put out flames in tunnels, factories, and even military installations.

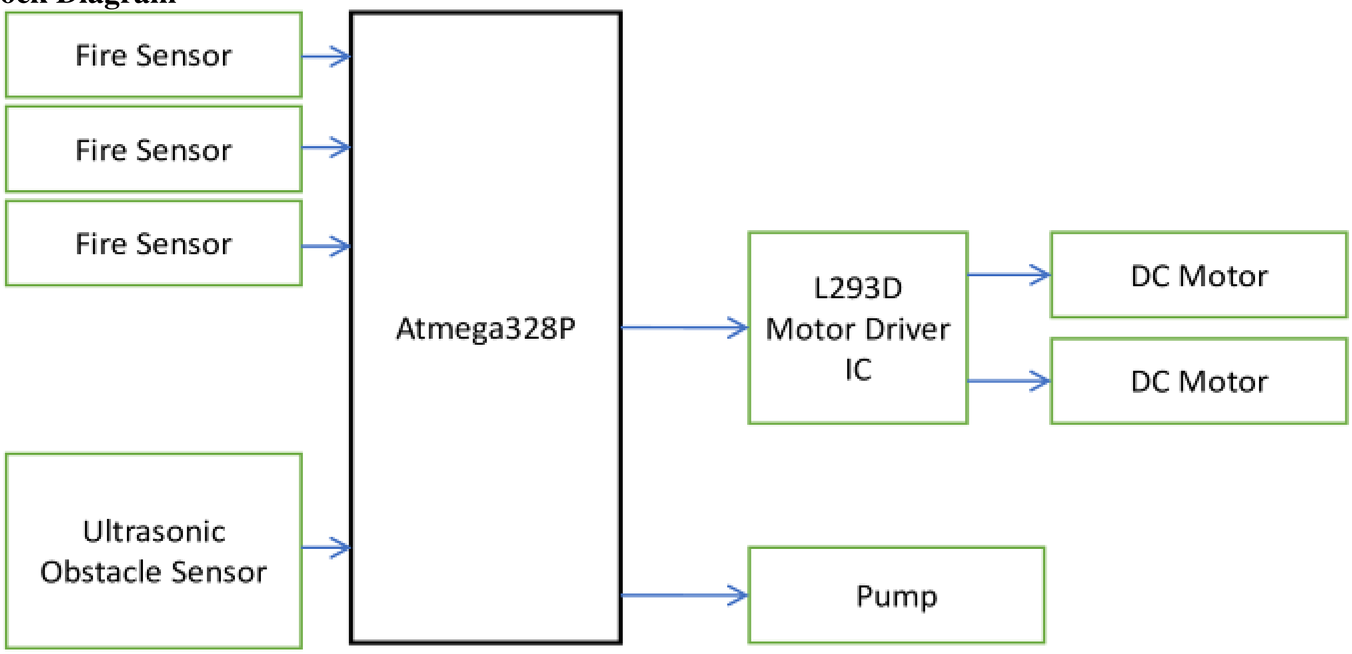
Using temperature sensors, one can detect fires. When a fire is detected, the automaton will move towards its location. The robot then controls a pump to saturate the fire with water. The concept of a fire-fighting automaton that can autonomously detect a fire and extinguish it using sensors, a microcontroller, and other electronic devices is elaborated upon. This automaton is utilised in environments where human lives are in danger. The construction of the tank robot utilises acrylic, plastic, aluminium, and iron. Completing the robot's hardware are the motor driver IC, temperature sensor, ultrasonic sensor, and two DC motors. The objective is to investigate a predetermined area, locate the fire's origin, and extinguish it using a variety of room configurations and disruption scenarios.

This paper describes the construction and design of a portable firefighting automaton. The device's two DC motors are separated optically from one another. The information gathered by the infrared sensors of the automaton is converted from analogue to digital

format. IR temperature sensors are utilised for fire detection. This extinguisher consists of a DC water compressor and a water tank. The central notion of the paper is to extinguish a detected fire. In this case, the input sensor is a temperature sensor that measures the thermal energy of the fire. The fire suppression system is microprocessor-controlled. The firefighting robot can move forward, backward, to the left and to the right. Therefore, firefighters can control the robot from a secure distance, eliminating the need for human intervention. The robot can monitor your home, office, business, or laboratory. It is a firefighting system integrated into a multisensory, intelligent security system.

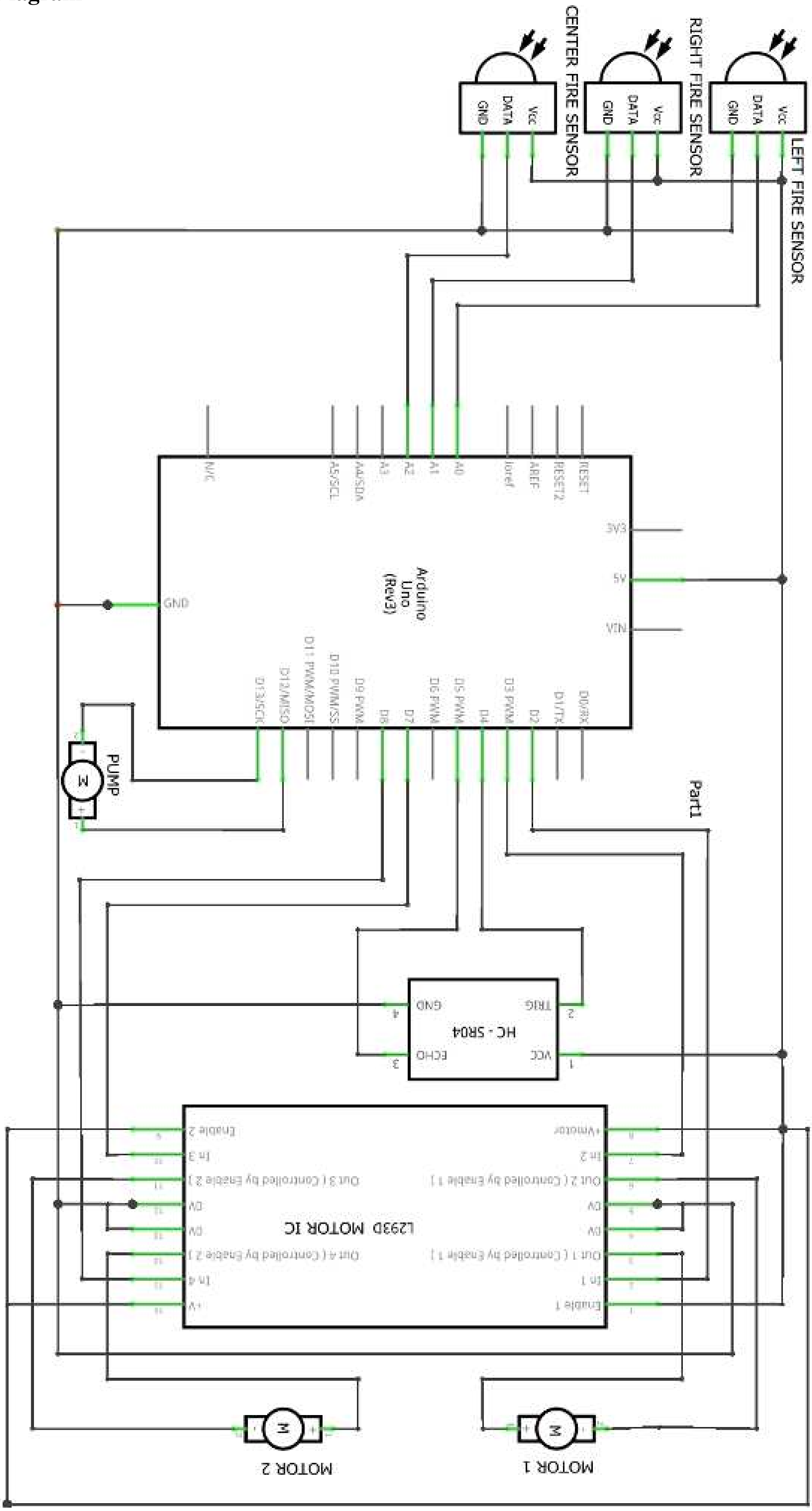
The circuitry of our endeavour is based on the Arduino Board. Connected to the controller board are the motor driver ICs, infrared sensors, and additional sensors (Arduino Board).

Block Diagram

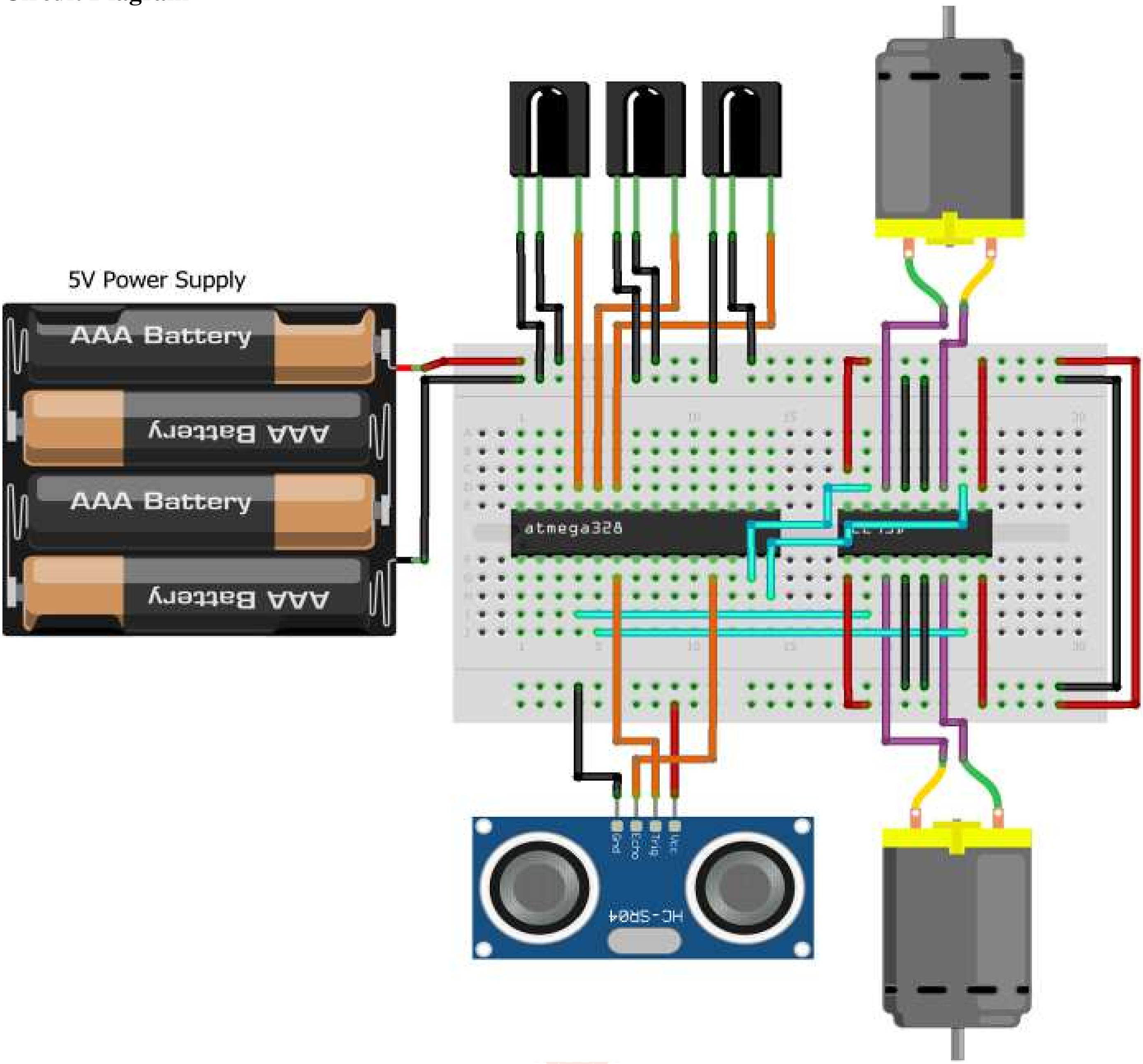


Arduino UNO is used for the control circuits of the automaton. Forward, left, and right portions of the robot each have a fire sensor that communicates with the control electronics. A fire hose and pump are prepared to extinguish it. An ultrasonic sensor is employed to detect objects. Automatically, the robot will avoid any obstacles in its course. Even more significant than the interface between the circuit's components is the Arduino programme installed onto the controller circuit. The Arduino sketch provides the software intelligence necessary to interpret the output of the fire sensors, steer the robot in the direction of the most intense fire, and modify the motor pump's output accordingly. Arduino IDE is utilized to programmed and compile Arduino sketches.

Schematic Diagram



Circuit Diagram



Working

The circuit's functionality is straightforward. The infrared (IR) sensors that detect flames are connected to the controller's analogue input pins as a voltage divider. The sensor's resistance changes when it is exposed to light from the flames. As the resistance of the IR receiver changes, the analogue voltage swings from ground to VCC. The built-in ADC channel of the controller reads the analogue voltage from the analogue input pin and converts it to a digital value. Because each Arduino UNO ADC channel is 10 bits wide, the digitised reading can range from 1023 to +1023. The sensors are programmed to detect flames at a distance of one metre. The code adjusts the threshold to an appropriate measurement relative to the calibration point. The identical calibration is applied to all three sensors.

The controller sends the robot forward when the front sensor detects fire; when the left or right sensors detect fire, the robot moves to the left or right. As the robot moves closer to the source of the fire, a fan or water pump attached to it is activated. The robot may be operated in any of four directions using the following input logic at the motor driver pins: forward, backward, left, and right.

Action	RHS Motor	LHS Motor	RHS Motor		LHS Motor	
			Pin 2	Pin 7	Pin 10	Pin 15
Move Forward	Clockwise Rotation	Anti-clockwise Rotation	LOW	HIGH	HIGH	LOW
Move Backward	Anti-clockwise Rotation	Clockwise Rotation	HIGH	LOW	LOW	HIGH
Turn Right	Stop	Anti-clockwise Rotation	LOW	LOW	HIGH	LOW
Turn Left	Clockwise Rotation	Stop	LOW		LOW	LOW
Stop	Stop	Stop	LOW	LOW	LOW	LOW

The sensor's threshold value has been set to 400. As a robot approaches a conflagration, the sensor value increases. When the sensor reading reaches 900, the automaton will stop and take appropriate action at that location. First, it advances in the direction of the most intense fire, and once that region is secure, it reverses course. If it was facing left prior to the fire being extinguished, it will now face right.

In response, a turbine is activated, allowing carbon dioxide gas to be directed at the source of the fire. Sending Low and High logic or High and low logic to pins 2 and 7 of the other motor driver IC will cause the attached fan to rotate either clockwise or anticlockwise. The fan can be turned in any direction. The fan's finalised design will direct carbon dioxide gas directly at the fire's origin. An alternative to the motor fan is a water pump, which can be interfaced with additional circuitry on the robot.

The robot design in this tutorial is an early iteration. The control circuitry and the body of a manufacturing robot should be contained in a fireproof enclosure. The body of a manufacturing automaton may include wheels and doors for convenience. It may be equipped with a larger battery cell and a powerful water pump or fan motor.

The obstruction is detected by an ultrasonic sensor. If the sensor detects an obstruction in its path, an output will be triggered, causing the robot to halt and recalculate its path to the source of the fire.

Program

```
#define LM1 2
#define LM2 3
#define RM1 7
#define RM2 8
#define trigPin 4
#define echoPin 5
int left = A0;
int right = A1;
int centre = A2;
int left_reading = 0;
int right_reading = 0;
int centre_reading = 0;
void moveforward();
void movebackward();
void turnleft();
void turnright();
void robostop();
int getDistance();
void setup()
{
 Serial.begin(9600);
 pinMode(LM1, OUTPUT);
 pinMode(LM2, OUTPUT);
 pinMode(RM1, OUTPUT);
 pinMode(RM2, OUTPUT);
 pinMode(9, OUTPUT);
 pinMode(10, OUTPUT);
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
}
void loop()
{
```

```
left_reading = analogRead(left); // A0 pin
Serial.print("left = ");
Serial.println(left_reading);
delay(500);
right_reading = analogRead(right); //A1 pin
Serial.print("right = ");
Serial.println(right_reading);
delay(500);
centre_reading = analogRead(centre); //A2 pin
Serial.print("centre = ");
Serial.println(centre_reading);
delay(500);
int distance = getDistance
Serial.print("distance = ");
Serial.println(distance);
delay(500);
if (distance <= 30
{
robostop();
Serial.println("Obstacle detected");
delay(500);
turnleft();
Serial.println("Turning left");
delay(1500);
} else if (left_reading < 1000)
{
turnleft();
Serial.println("Turning left");
delay(1300);
moveforward();
Serial.println("Moving forward");
if (analogRead(centre) < 40)
{
robostop();
Serial.println("Fire detected");
digitalWrite(9, HIGH);
digitalWrite(10, LOW);
delay(5000);
digitalWrite(9, LOW);
digitalWrite(10, LOW);
}
delay(1100);
turnright();
Serial.println("Turning right");
delay(1300);
robostop();
} else if (right_reading < 1000) {
turnright();
Serial.println("Turning right");
delay(1300);
moveforward();
Serial.println("Moving forward");
if (analogRead(centre) < 40) {
robostop();
Serial.println("Fire detected");
digitalWrite(9, HIGH);
digitalWrite(10, LOW);
delay(5000);
digitalWrite(9, LOW);
digitalWrite(10, LOW);
}
delay(1100);
turnleft();
Serial.println("Turning left");
delay(1300);
robostop();
} else if (centre_reading < 1000) {
moveforward();
Serial.println("Moving forward");
if (analogRead(centre) < 40) {
robostop();
Serial.println("Fire detected");
digitalWrite(9, HIGH);
digitalWrite(10, LOW);
delay(5000);
digitalWrite(9, LOW);
digitalWrite(10, LOW);
}
delay(1100);
}
else
{
robostop();
Serial.println("No Fire and Obstacle Detected");
delay(500);
}
}
void moveforward()
{
digitalWrite(LM1, HIGH);
```

```
digitalWrite(LM2, LOW);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, LOW);
}
void movebackward()
{
digitalWrite(LM1, LOW);
digitalWrite(LM2, HIGH);
digitalWrite(RM1, LOW);
digitalWrite(RM2, HIGH);
}
void turnleft()
{
digitalWrite(LM1, LOW);
digitalWrite(LM2, LOW);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, LOW);
}
void turnright()
{
digitalWrite(LM1, HIGH);
digitalWrite(LM2, LOW);
digitalWrite(RM1, LOW);
digitalWrite(RM2, LOW);
}
void robostop()
{
digitalWrite(LM1, LOW);
digitalWrite(LM2, LOW);
digitalWrite(RM1, LOW);
digitalWrite(RM2, LOW);
}
int getDistance()
{
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
long duration = pulseIn(echoPin, HIGH);
int distance = duration * 0.034 / 2;
return distance;
}
```

Code Explanation

The Arduino Sketch converts the analogue output of the IR receivers to a digital value, which is then compared to a specified threshold. If the sensor's value exceeds the set threshold, the robot will turn in that direction and operate the fan or water pump. First, the connections between the motor driver IC and the fire detection sensors, as well as the constants and variables connected with them, are defined. The robot has obstacle avoidance sensors and will promptly reverse course if it finds an object in its route.

In the void loop() method, the following code snippet receives the analogue readings from the left and right fire sensors, as well as the front and centre sensors and the ultrasonic sensor.

```
left_reading = analogRead(left); // A0 pin
 Serial.print("left = ");
 Serial.println(left_reading);
 delay(500);
 right_reading = analogRead(right); //A1 pin
 Serial.print("right = ");
 Serial.println(right_reading);
 delay(500);
 centre_reading = analogRead(centre); //A2 pin
 Serial.print("centre = ");
 Serial.println(centre_reading);
 delay(500);
```

The following block of code in void loop() function represents reading the values from the Ultrasonic sensors on the centre (front) for obstacle avoidance

```
 int distance = getDistance(); // Read the distance from the ultrasonic sensor
 Serial.print("distance = ");
 Serial.println(distance);
 delay(500);
```

When left-most flames are detected, the subsequent code block is executed. When the value of the left-mounted analogue sensor falls below 1000 (the calibrated threshold), the robot moves in that direction until it is close to the fire. The sensor value will continue to increase as the robot approaches the fire. When the sensor reading falls below 40, the automaton will stop and activate the water pump to extinguish the fire. After the fire has been extinguished and the centre value of the sensor has risen above 1000, the robot turns left.

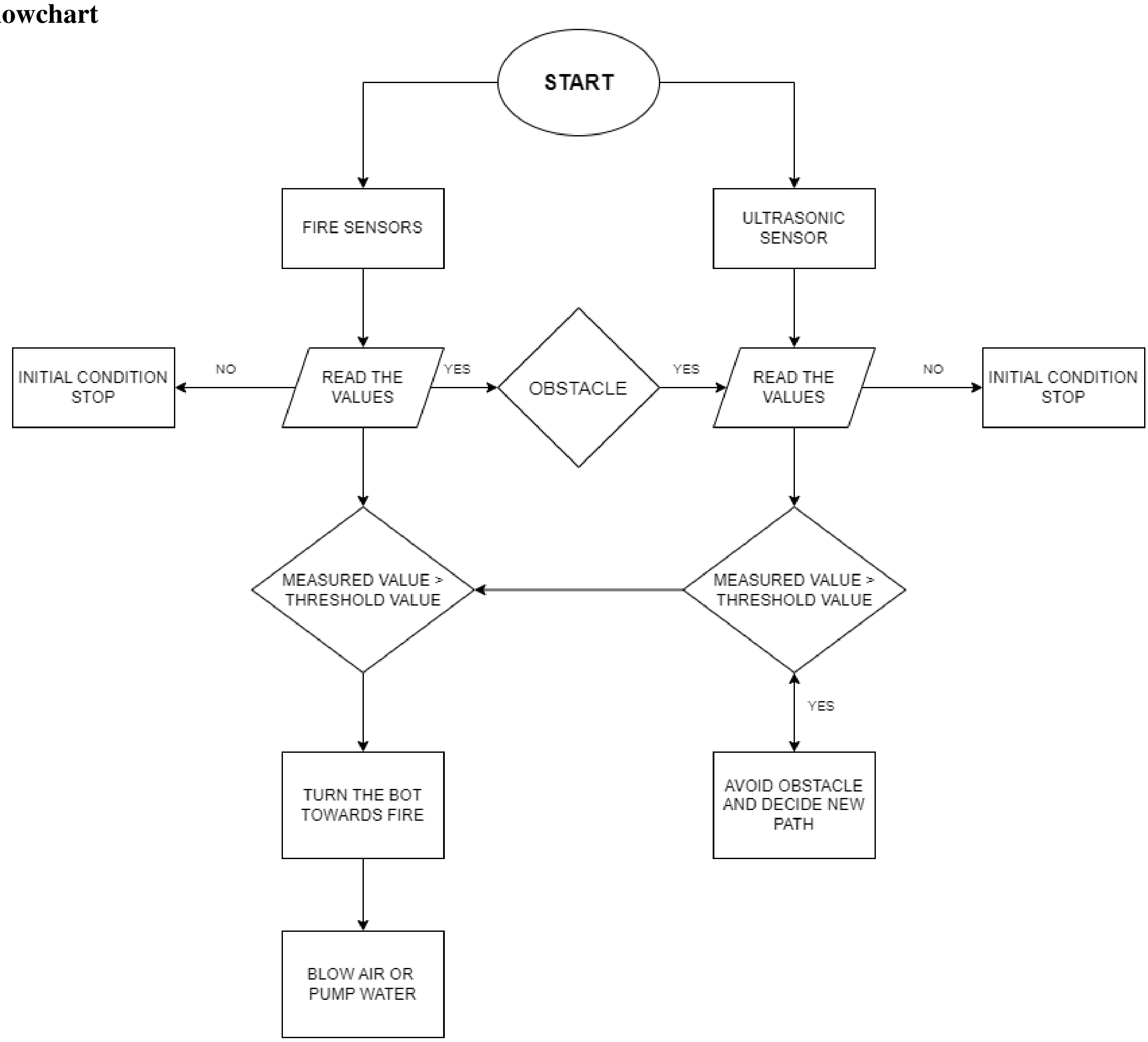
```
else if (left_reading < 1000)
 {
 turnleft();
 Serial.println("Turning left");
 delay(1300);
```

```
moveforward();
Serial.println("Moving forward");
if (analogRead(centre) < 40)
{
robostop();
Serial.println("Fire detected");
digitalWrite(9, HIGH);
digitalWrite(10, LOW);
delay(5000);
digitalWrite(9, LOW);
digitalWrite(10, LOW);
}
delay(1100);
turnright();
Serial.println("Turning right");
delay(1300);
robostop();
```

When the next code block is reached, the sensor has identified the obstruction. When the front-mounted sensors detect a value less than 1000 (the calibrated threshold), the robot will avoid the obstruction by turning to the left and continuing forward. As the robot approaches the fire, the sensor value will continue to diminish. When the sensor value falls below 40, the robot pauses and the water pump is activated to extinguish the fire. After the fire is extinguished and the central value of the sensor rises above 1000, the robot turns left.

```
if (distance <= 30) //if obstacle is detected, stop the robot and turn left
{
robostop();
Serial.println("Obstacle detected");
delay(500);
turnleft();
Serial.println("Turning left");
delay(1500);
}
```

Flowchart



Future Scope

For the future development, we can add LiDAR sensor, camera to map out and able to see whole environment. We can use Android or iOS platform to monitor the robot. We can also add alerting system which will directly call ambulance and Fire Station for help. We can use different chemicals to extinguish fire cause by different reasons.

Conclusion

This project describes a real-time firefighting robot that can maintain a constant speed while moving, find a fire, and then extinguish it with the use of a fan. It has a lightweight structure and a compact body, as well as useful features such as the ability to automatically detect the location of a fire. Because of its tiny design, the robot can be used in areas with limited space as well as locations with few entry points. The technology has the potential to aid firefighters in putting out fires and preventing future fires. Any flames that may arise are automatically extinguished by the operator.

References

[1] https://www.youtube.com/

[2] “Implementation methods of firefighting robot” Author - Mrs. Bhavna K. Pancholi, Miss. Kena Pate

[3] “Fire Extinguishing Robot using Arduino” Author - Abdülkadir ÇAKIR, Nyan Farooq Ezzulddın EZZULDDIN

[4] “Fire Extinguishing Robot using IoT” Author - Prof. Sankalp Mehta, Sujata Tupale , Shilpa Kappalguddi, Sangharsha Madvanna, Rakshanda Patil

[5] “Fire Fighting Robot” Author - Sapkal Saraswati, Mane Bharat, Prof. V. U. Bansude, Makhare Sonal.

[6] www.wikipedia.org